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INFRASTRUCTURE, MARKET ACCESS, AND AGRICULTURAL PRICES: EVIDENCE FROM MADAGASCAR

BY

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ABSTRACT

The effect of recent agricultural market reforms in many developing countries is often measured through tests for market integration by analyzing co-variation of food prices. However, market integration studies often fail to link the discovery of the lack of integration to causal factors. This analysis documents and relates price variation to structural determinants in the case of Madagascar. The spatial variability between communities is linked to the distance to a paved road, the quality of the road, access to soft infrastructure, and the level of competition between traders. Differences in seasonal variation are mainly related to the differential opportunity costs of capital in rice villages and to hard infrastructure in non-rice villages. Communities that lack basic infrastructure show lower prices during the harvest season and higher seasonal gaps. Moreover, it is shown that road distance matters more than road quality during the harvest period as there is no strong relationship between road quality and the producer price decline per unit of time. While the presence of roads shows up in relatively higher producer prices, it does not automatically lead to more competition among traders. Hence, investment in hard infrastructure is not sufficient to successfully increase market access. However, soft infrastructure on top of hard infrastructure seems beneficial for increased producer prices, reduced price variability, and improved market integration.

1. INTRODUCTION

Variation in agricultural prices is a central factor for household food security as prices determine the income received for food crops by selling households and the ability to purchase food for consumer households. The switch from fixed to liberalized prices in agricultural markets in many developing economies has significantly influenced village and household welfare after reforms. The presence of infrastructure often determines if a village receives higher or lower prices after market liberalization as transport costs, different due to distance and the quality of infrastructure, influence how the benefits (costs) from a liberalized environment are shared between producers and other economic agents, i.e. transporters, middlemen, and consumers.

In a liberalized environment, the presence of infrastructure, such as roads and market sites, is expected to increase the efficiency of both marketing and production as they reduce transactions costs and ensure more competitive pricing conditions in marketing than would occur in their absence. Previous research on the impact of marketing infrastructure on agriculture concludes that road quality increases the use of fertilizer (Ahmed and Hossain 1990) and enhances total agricultural output with an elasticity of about 0.20 (Binswanger et al. 1993). It has been shown that deficient transport infrastructure is an important determinant of low technological adoption, cropping choices and of low agricultural productivity in developing countries (Omamo 1998; Zeller et al. 1998; Von Oppen et al. 1997; Antle 1983) while price policies, with respect to transport pricing might create distorting signals. For example, Gersovitz (1989, 1992) shows how panterritorial pricing affects transport investment strategies while Masters and Nuppenau (1993) show how liberalization would improve efficiency and equity in the case of maize in Zimbabwe.

A second strain of literature on the relation of infrastructure and agriculture looks at the impact of transport costs on agricultural price behavior after liberalization. Goetz (1992) and de Janvry et al. (1991, 1992) argue that due to transaction costs, a household specific price band exists for the same commodity between its purchase and selling price. The poorer the infrastructure, the greater the size of the band. The measure of market integration - one of the objectives of market reforms - has been studied extensively, methodologically as well as empirically, in the recent literature, for example by Alexander and Wyeth (1994), Alderman (1993), Badiane and Shively (1998), Barrett (1996), Bauch (1997), Dercon (1995), Fafchamps (1992), Fafchamps and Gavian (1996), Goletti et al. (1994), and Mendoza and Rosegrant (1995). However, while the measurement of the extent of market integration after reform is important, clear policy implications do not often follow directly from the results of market integration models as the discovery of lack of spatial or temporal integration might be due to a variety of factors.

In a well-functioning liberalized economy prices should reflect costs to move products in space, time, or form. The contribution of this paper is to study the structural determinants of price variation over space and time and to illustrate the quantitative importance of their effects based on a unique, extensive, and recent community survey in the liberalized environment of Madagascar. The structure of the document is as follows. First, the data and descriptive statistics for the study region are presented. Price levels and seasonal movements in road conditions, product prices, and urban rural price ratios are then discussed. Subsequently, the methodology is presented, and determinants of market access, price levels, and price variability are analyzed. The last section closes with the main findings and implications.

2. DATA AND DESCRIPTIVE STATISTICS

DATA

The International Food Policy Research Institute (IFPRI) and the local Ministry of Scientific Research (FOFIFA) organized a community survey in May 1997 in Madagascar. One hundred and eighty eight communities were randomly selected using a stratified sampling frame that distinguished strata based on agro-ecological conditions, village size, and the distance from the village to the nearest tarred road[1]. This survey contained information on the levels (in 1997) and changes (compared to 10 and 5 years ago) in the demographic characteristics, agricultural production systems, agricultural input and output markets, access to infrastructure, and environmental data in the community.

These data were collected in the *faritany* (regions) of Mahajanga, Fianarantsoa, and in one sub-region of Antananarivo (Vakinankaratra), the three main production regions in Madagascar. Each of the faritany was divided into agro-ecological zones that served as the basis for the stratified sampling. Within the faritany of Mahajanga, three agro-ecological strata are differentiated: Mahajanga - plains, characterized by the existence of large irrigation schemes, the highlands ("Plateaux") of Mahajanga, and the rest of Mahajanga. Within the faritany of Fianarantsoa, three agro-ecological zones were also differentiated: the highlands ("Hautes Terres"), the foothills ("Falaise"), and the coastal ("Côte") regions. In the tables presented in this paper, we aggregate the latter two

[1] For a detailed overview of methodology and sampling frame, see Ralison et al. (1997).

regions into a subregion called Côte/Falaise of Fianarantsoa. We do the same for the Mahajanga Plateaux region. In the analysis of descriptive statistics as well as regressions, each community is weighted to reflect its importance in the total population.

MARKET ACCESS AND PRICE LEVELS

Only 8 percent of the *fokontany* report a regular market within the fokontany (Table 1)[2]. Most markets are only regularly held in the chef-lieu of the *firaisana*. The average distance to the main market for the sample as a whole is almost 10 km. This distance is as high as 21 km for Mahajanga - Plateaux where it takes, on average, almost 5 hours to get to the market. The longer distance implies that people take the oxcart ("charette") relatively more often to go to the market–37 percent in Mahajanga - Plateaux–while in other regions transport by foot is almost the only transportation used. Compared to the other regions, it seems that Mahajanga - Plateaux has the most difficult access to market outlets given the low number of fokontany that have a market and the longer time required to get to a market.

[2] Fokontany = village; firaisana = district; fivondronana = subregion; faritany = region

Table 1-Characteristics of market access

Region	Fokontany that have a market	Average distance to market	Average time to reach market	Importance of transport by foot
	(percent)	(km)	(hours)	(percent)
Mahajanga:Plains	5.9	6.64	1.70	71.8
Mahajanga:Plateaux	2.0	21.41	4.70	57.3
Fianar:Highlands	4.3	6.30	1.22	95.7
Fianar:Côte/Falaise	16.7	4.31	0.89	100.0
Vakinankaratra	11.0	8.27	1.41	92.8
Total	8.0	9.71	2.03	86.6

Source: IFPRI/FOFIFA - community survey, 1997 (n=188 communities)

To assess changes in competition levels between traders, the fokontany leaders were asked if they could always, never, or occasionally choose between traders to sell their agricultural products. Fifty-one percent of the communities report that they can always choose between traders while 27 percent of the communities in the overall sample report they can never choose (Table 2). The possibility of choice among traders in food marketing is quite different for the different regions. Almost all the communities in Fianarantsoa - Côte/Falaise and Mahajanga - Plains report that they can always choose between different traders to sell their products while only 27 percent and 33 percent in Fianarantsoa - Highlands and Mahajanga - Plateaux respectively report they can do so. On average, the competition - to the extent that choice reflects competition - seems to be more intense in 1997 than five years earlier: 45 percent of the communities could always choose between traders five years ago compared to 51 percent now. The number of communities that could never choose declined slightly from 29 percent to 27 percent. The situation improved dramatically in Fianarantsoa - Highlands while it got a little worse in the Vakinankaratra region.

Table 2-Possibility of choice between different traders to sell main agricultural products (recall by village leaders)

Region	Choice	1997	Five years earlier (1992)
Mahajanga:Plains	Always	91.7	88.3
	Never	8.3	11.7
	Total	100.0	100.0
Mahajanga:Plateaux	Always	33.1	27.8
	Occasionally	29.1	34.4
	Never	37.7	37.7
	Total	100.0	100.0
Fianar:Highlands	Always	26.9	13.1
	Occasionally	36.4	39.4
	Never	36.7	47.5
	Total	100.0	100.0
Fianar:Côte/Falaise	Always	85.3	83.5
	Occasionally	6.9	12.3
	Never	7.8	4.2
	Total	100.0	100.0
Vakinankaratra	Always	59.8	60.6
	Occasionally	10.7	13.0
	Never	29.5	26.4
	Total	100.0	100.0
Total	Always	51.3	45.2
	Occasionally	21.6	25.6
	Never	27.1	29.2
	Total	100.0	100.0

Source: IFPRI/FOFIFA - community survey, 1997 (n=188 communities)

Good market access is one of the factors that influence price levels. Monthly prices for different products during the June 1996 to May 1997 period were gathered. As the different regions are characterized by different production seasons, the lowest price of rice during the year was taken to allow comparisons of the price level between regions. Rice prices are lowest in the Mahajanga -

Plateaux (964 Fmg/kg)[3] and in Fianarantsoa - Highlands (1077 Fmg/kg). In the other regions, average rice prices are almost at the same level (1215 Fmg/kg) and 26 percent higher on average than in the Mahajanga Plateaux (Table 3). The standard deviation of rice prices within each region are lowest in the Vakinankaratra and the Fianarantsoa - Highlands regions reflecting a more homogenous situation and smaller differences in infrastructure compared to other regions. Compared to other products such as cassava, the spatial variation for the price of rice is small reflecting its omnipresence.

SEASONAL MOVEMENTS

Seasonality is an important defining characteristic of agricultural activities in general, and Malagasy agriculture and marketing more specifically. Seasonality shows up in different growing seasons, timely marketing periods, changing consumption patterns, and food prices. It is possible that changes in marketing after liberalization have made for increased variability of prices and/or for increased seasonal price movements[4]. If poorer households do not have the liquidity to smooth consumption, such variability might result in a welfare loss and contribute to malnutrition. This seems to be the case. UNICEF estimates that malnutrition levels are 15 percent higher during the lean season than during the harvest season (SECALINE 1996). It seems that the seasonal movement in prices is more harmful for poorer households as they are disproportionally buyers of rice during the lean season (Barrett and Dorosh

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[3] The price was asked as a purchase price in Ariary of one "kapoaka" of low quality (C2) rice (1 Ariary = 5 Fmg; 3.5 kapoaka of rice = 1 kg).

[4] See Barrett (1997) for an in-depth analysis in rural areas; see Minten (1997) for analysis at the urban level.

Table 3-Prices and standard deviation for different products at time of survey (in Fmg)

Region		Kg of rice	Kg of dry cassava
Mahajanga:Plains	Mean	1220	636
	Std. Deviation	271	263
	Median	1225	500
Mahajanga:Plateaux	Mean	964	668
	Std. Deviation	263	184
	Median	875	625
Fianar:Highlands	Mean	1077	611
	Std. Deviation	129	114
	Median	1050	600
Fianar:Côte/Falaise	Mean	1218	921
	Std. Deviation	255	453
	Median	1231	800
Vakinankaratra	Mean	1212	510
	Std. Deviation	177	290
	Median	1225	500
Total	Mean	1113	638
	Std. Deviation	236	252
	Median	1050	600

Source: IFPRI/FOFIFA - community survey, 1997 (n=188 communities)

1996; Minten et al. 1998). This section discusses seasonal movements in marketing periods and agricultural prices, agricultural price ratios between rural areas and urban centers, and road conditions.

Infrastructure and Seasonal Movements in Road Conditions

The variability in the quality of road infrastructure, over time and space, is presumably an important explanatory variable of price levels and seasonal spreads of agricultural product prices in the different fokontany. Eight percent,

57 percent, and 72 percent of the fokontany in the survey region respectively report a paved road, a non paved all-season road, and a seasonal road within their fokontany (Table 4). It takes, on average, 4.1 hours and 0.9 hours to get to the paved and non-paved all season road during most of the marketing period (dry season). Differences in price levels between seasons are caused by different production conditions and storage costs, but also by transport costs and changing road conditions between the wet and the dry season. An estimate of the time required to get to the main roads and secondary roads shows that the difference between these two periods is quite significant. The time required to get to a paved road in the Mahajanga - Plateaux area during the rainy season is more than twice the time during the dry season. In some cases, it is impossible to get to the paved road during the rainy season and other means of transport, such as water transport, have to be used. The difference in time required to get to a paved road between the dry and the wet season is smallest in the Vakinankaratra and Fianarantsoa - Highlands region where it is less than 15 percent.

Table 4-Characteristics of access to road infrastructure

Region	Available in fokontany			Time required to get to			
				Wet season		Dry season	
	Paved road	All-season road	Seasonal road	Paved road	All-season road	Paved road	All-season road
	(percent)			(hours)			
Mahajanga:Plains	17.8	31.4	85.6	2.24	1.78	1.88	1.28
Mahajanga:Plateaux	1.2	29.7	73.3	20.68	3.98	10.31	2.51
Fianar:Highlands	7.5	76.9	80.8	1.87	0.20	1.53	0.20
Fianar:Côte/Falaise	12.1	53.1	53.8	3.94	0.71	3.09	0.60
Vakinankaratra	10.1	71.0	77.5	2.82	0.59	2.42	0.17
Total	8.1	56.6	71.8	7.01	1.36	4.15	0.90

Source: IFPRI/FOFIFA - community survey, 1997 (n=188 communities)

Seasonal Movements in Prices

Different regions are characterized by differences in seasonal gaps and the timing of peaks and troughs. For example, in Mahajanga, the highest price is from February to April (Figure 1) while in Vakinankaratra, it is from November through February. The biggest amplitude in 1997 could be detected in the Mahajanga - Plateaux region (Table 5) as prices during the lean season were more than triple the prices after the main harvest season. The smallest amplitudes are seen in the Vakinankaratra and the Fianarantsoa - Haut Terres region. However, prices during the lean season are still double the prices in the harvest season in these regions. It is surprising to note that the seasonal movement in Mahajanga - Plains shows the same magnitude as those in other regions despite the presence of three distinct production seasons in this region. However, it is evident that the "vary jeby" constitutes the major harvest period as shown by the area under cultivation and the lower price during the month of November[5].

[5] Rasoarimanana (1996) estimates that the vary jeby makes up 40 percent of total cultivated area in the Marovoay plains region compared to 40 percent for the vary asara and 20 percent for the vary atriatry.

Figure 1-Income from commercial surplus Mahajanga - Plains (Fmg/month per household (Oct. 95-Sept. 96))

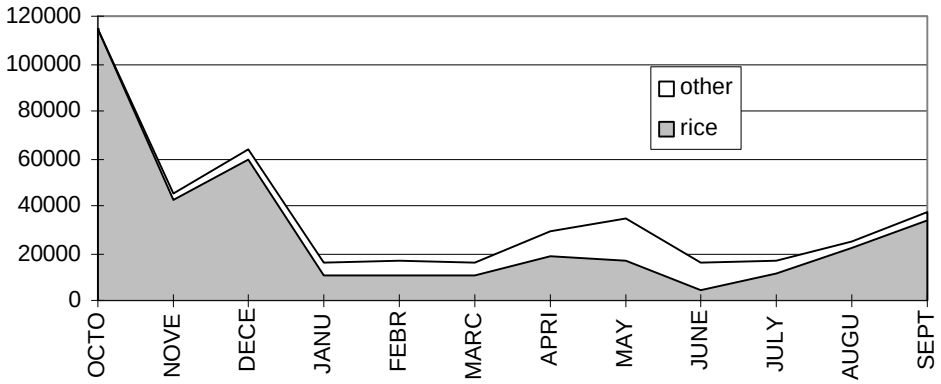

Table 5-Lowest and highest rice price and seasonal gap (June 96 - May 97)

Region		Rice price		Seasonal gap
		Lowest	Highest	
		(Fmg/kg)		(Fmg)
Mahajanga:Plains	Mean	1220	2443	1223
	Std. Deviation	271	307	402
Mahajanga:Plateaux	Mean	964	2935	1971
	Std. Deviation	263	789	810
Fianar:Highlands	Mean	1077	2076	998
	Std. Deviation	129	236	286
Fianar:Côte/Falaise	Mean	1218	2384	1166
	Std. Deviation	255	214	301
Vakinankaratra	Mean	1212	2193	981
	Std. Deviation	177	274	349
Total	Mean	1113	2394	1281
	Std. Deviation	236	544	616

Source: IFPRI/FOFIFA - community survey, 1997 (n=188 communities)

If rice markets would function efficiently, the distinct differences in seasonal rice production and prices for different regions would be to the benefit of large rice

importing, higher price areas, such as Antananarivo, as they would be able to procure their rice from those exporting regions where the price is lowest at that moment. Hence, seasonal movements in big urban centers are often much lower than in rural areas[6]. Due to these different price patterns, optimal storage periods at the village level differ between different rural regions. Storage for six months in Mahajanga - Plains and Fianarantsoa - Côte/Falaise results in rates of return between 75 percent and 90 percent.[7] The higher level of return in a shorter period in Mahajanga - Plains might be due to the different harvest period (November) which allows this region to sell rice at the time of the lean period in other regions. The lowest rate of return is noticed in the Vakinankaratra region where storage profitability shows a smooth and slow increase over time.[8]

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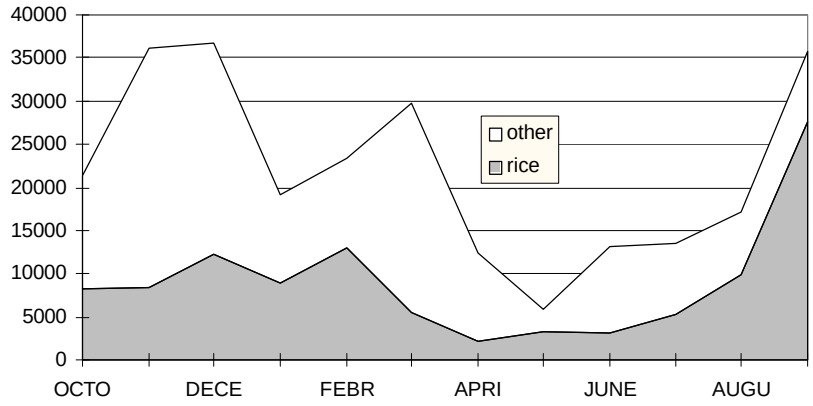
[6] Minten (1997) shows that the seasonal movement for rice in Antananarivo over the last decade was only 25 percent.

[7] The rate of return was calculated by dividing the difference in prices between each consecutive post-harvest month and the harvest month by the price during the harvest month. No losses were imposed. Hence, rates of return are overestimated. It is also dangerous to invoke profitability of storage based on one year data. Hence, although the rates might be indicative, caution in interpretation is warranted.

[8] The high level of return in Mahajanga - Plateaux might be an extreme value as it seems that diseases (rice fleas, virose) and inundation hit this region hard during the 1997 season. However, anecdotal evidence suggests that it can reasonably be assumed that even in normal years, seasonal gaps are quite high in this region.

The seasonal movement in spatial price variation over all the fokontany over one season follows the same pattern as the price level of rice (Figure 2). Spatial variation in prices, as measured by its standard deviation, is less during the post-harvest season - when prices are low - than during the lean period[9]. Variation is highest during the months of March and April and lowest from May to July. This decline in spatial variation in rice prices seems to be due to better road conditions, lower transport costs, and the almost universal situation of rice exports out of the villages during the dry season. The importance of the thin markets argument is illustrated by the fact that the standard deviation is low in the month of November/December in Mahajanga
- Plains, i.e. during the harvest period in that region, although the road situation is already bad during that period.

Figure 2-Income from commercial surplus Mahajanga - Plateaux (Fmg/month per household (Oct. 95 - Sept. 96))



[9] The same variation is noticed in a temporal analysis of seasonal movements in one location (Antananarivo): price stability is higher when prices are low and vice-versa.

Seasonal Movements in Rural - Urban Price Ratios

The difference in the magnitude of the seasonal movements for different regions also often reflects effective physical flows that are reverted during the year. Figure 3 shows how urban - rural price ratios change over the course of the season in Fianarantsoa city and Antsirabe city and nearby rural areas[10]. Prices in urban areas are higher during the harvest and post-harvest period (from April through September) and lower during the lean period (October through March). It seems that a large part of commercial stocks are stored in towns after the harvest and then moved back from towns to rural areas during the lean season[11]. It is clear that this has effective impact on the food security situation of these communities[12].

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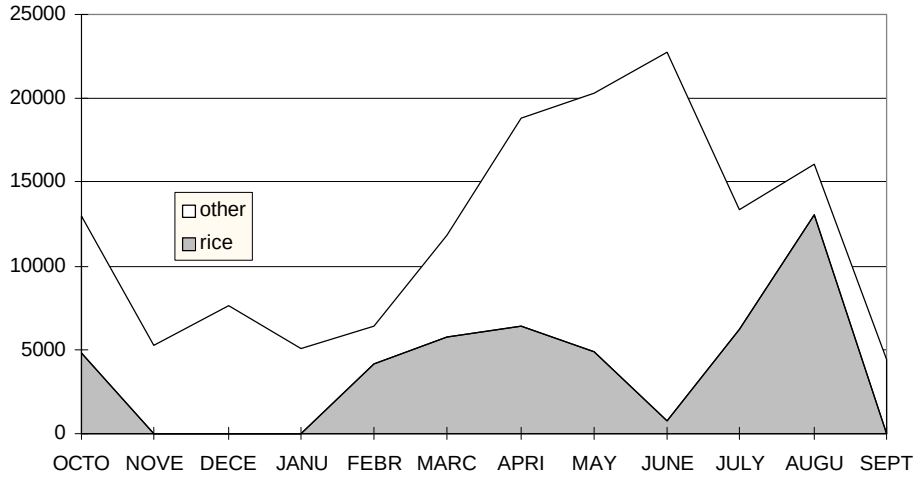
[10] Fianarantsoa II (rural) compared to Fianarantsoa I (town); Antsirabe II (rural) compared to Antsirabe I (town).

[11] For example, Barrett (1997) estimates that 93 percent of the interseasonal storage capacity of the Vakinankaratra region is located in the urban center of Antsirabe.

[12] This situation also creates problems with traditional market integration measures used in previous studies. Low integration coefficients, as measured by correlation coefficients or simple regression models, do not necessarily mean that markets are segmented or not integrated. Even if you have effective physical flows between different regions and arbitrage opportunities are effectively dealt with, you still might come up with low integration coefficients. Hence, the importance of segmented markets in Madagascar might have been overstated in previous studies (Azam et al. 1992; Roubaud 1997). See also Minten et al. (1998) for a more extensive discussion of the buying and selling behavior of rural households.

Results from the output trader survey seem to indicate that these flows are not only confined to cities and their nearby rural areas, but that they seem to encompass even broader rural urban rice movements. Rice flows seem to go from Mahajanga - Plateaux to Mahajanga city during the harvest while the reverse happens during the lean period. The same is partly true in the Fianarantsoa region. Rice goes from Fianarantsoa - Highlands to Fianarantsoa city during the harvest season and back during the lean season. Another part of the commercial rice goes to the Fianarantsoa - Côte/Falaise region. However, without effective data on flows available, caution is warranted as the shift in price ratios could also be observable in case of market segmentation, which would leave better supplied urban centers with lower prices without any reverse flows taking place. Further, it might also be the case that some regions are effective deficit regions and rural areas are supplemented with imported rice from elsewhere.

Figure 3–Income from commercial surplus Fianarantsoa - Highlands etc. (Fmg/month per household (Oct. 95 - Sept. 96))



3. DETERMINANTS OF MARKET ACCESS AND PRICES

METHODOLOGY

In this section, determinants of market access, price levels, and price variability are explored. If effective flows exist between rural areas and urban centers, prices would be expected to follow the relationship:

$$P^p = P^C - T - A - R$$

where P^p represents the village or producer price, P^C the consumer price, T transportation costs, A transaction costs, and R rents. In a competitive market, R would be zero and differences between consumer and producer prices would reflect only transportation costs and transaction costs. In a non-competitive market, the margins would be higher than the sum of the two categories of costs. As these different costs are difficult to measure directly, proxies are used in the empirical estimation. Transportation costs seem to be mostly related to hard infrastructure (H) and transaction costs, mostly to soft infrastructure (S). Rents by traders could be reflected in monopoly or oligopoly positions of traders, measured by the possibility of choice between traders (C). Regional dummies are included in the regression to reflect the distances of the respective rural fivondronana (D), in which the villages were selected, and the cities, or between producers and consumers. The estimated model is as follows:

$$\text{Price levels } (P^p) = f(H, S, C, D)$$

The right-hand side variables in the previous regression are assumed to be related. Given that construction, upgrading, and maintenance of hard infrastructure is often important for public policy decisions, we will specifically look at its relationships with prices and other variables, and more specifically how it affects the possibility of choice between traders, the number and type of

traders that buy in the area, and the presence of soft infrastructure. While infrastructure can be considered an exogenous variable in determination of choices between traders, the relationship between soft and hard infrastructure is more complex. While soft infrastructure responds to hard infrastructure, the process also works the other way as governments tend to allocate their infrastructure investments in response to the agro-climatic potential of regions, i.e. in the same way as soft infrastructure tends to be allocated. Accordingly, just the relationship is illustrated, without invoking causality by lack of available instruments. The form for the choice between traders regression is the following:

$$\text{Choice between traders/ type of trader (C)} = f(H, S, D)$$

The last empirical part of this section looks at the determinants of seasonal spreads in prices over an agricultural year (June 1996 - May 1997). Under the assumptions of perfect competition, seasonality would reflect the cost of storage plus the normal profits of the storage agent. These costs would reflect fixed costs (wages, storage facilities, etc.), variable costs (interest payments, weight loss, variable labor costs, etc.), and a risk premium for holding on to stocks. Even in the case of perfect competition, if storage does not happen in the consumption site, transportation costs have to be added in the seasonal spread and different regions might supply a specific village at a different time (Benirscha and Binkley 1995). In practice, higher seasonality could also be related to oligopsonist trading or non-competitive market practices and uncertainty in seasonal price movements to expectations. Moreover, indirect policy interventions also affect seasonal spreads as through the promotion of competitive markets, they might reduce the cost of inter-temporal arbitrage by lowering risks, constraints, and transactions costs (Sahn and Delgado 1989). As none of these costs are directly available, the estimated model is formulated in a reduced form:

$$\text{Seasonal spread } (P^{pt} - P^{p0}) = f(W, Cr, S, H, C, R, D)$$

where W represents wages, Cr access to credit, and R a co-variant risk factor. The other variables retain the same meaning as in the previous equations.

Given the omni-presence of rice in the survey region, this product is well-suited to study the determinants of the level and the variability of prices. Seasonality was calculated as the difference between the lowest and the highest monthly rice price during the period June 1996 - May 1997. To incorporate the effect of distance, different categories were constructed that reflect communities close to, at a medium distance to, and far away from the main paved road. The division in these three categories was based on the time required to get to a paved road during the dry season, i.e. the period when most agricultural products are sold. Close to the paved road were communities that are within less than two hours walking time from the paved road; medium distance, between two and eight hours and far away, more than eight hours. To estimate the effect of the road quality, these three categories were considered with communities that had access to the main road through an all-season road, a seasonal road, or no road at all in their fokontany. In the analysis we end up with eight categories[13]. The default prices are prices in communities that have access to a paved road in their fokontany. An index measuring access to soft infrastructure was constructed which reflects measures of access to credit, information, security, and agricultural inputs[14].

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[13] As there were not enough observations in the medium distance - no access to roads category, this category was aggregated with the close to paved road but no access to roads category.

[14] The index was a simple sum of no access (0) or access (1) to the different variables in the fokontany: commercial banks, savings deposit, post office, public telephone, link radio-contact (BLU), electricity, police, chemical fertilizer, improved varieties of rice, and agricultural extension.

PRICE LEVELS

Rice prices during the harvest periods were taken as dependent variables for the price level regression as most fokontany do sell and export rice during that period. As expected, hard infrastructure matters for agricultural price levels. The distance to the main paved road and the quality of the road infrastructure connecting to the main road are significant determinants of rice prices as shown in the reduced form (Table 6 - Model 1). Communities that have access to all-season roads show, on average, higher prices than communities that have only access to seasonal roads or communities that do not have access to roads. Communities that are far away from the main road show lower prices than communities that are close to the main road. The negative signs are an indication that all prices in communities off the paved road are lower than in communities that have access to paved roads. The consistent signs seem to be an indication of the fact that spatial markups reflect costs of transport and handling. However, to analyze the extent to which this is the case, price changes as a function of distance and hours traveled are calculated.

Table 6-Regression of the impact of distance to paved road and quality of infrastructure on producer price levels of rice (Fmg/kg)

Independent variables	Model 1**			Model 2		
	Coefficients	t-value	Significance	Coefficients	t-value	Significance
Intercept	1280.31	17.13	0.000	1177.04	13.68	0.000
Dummy fok. with no road - medium distance to paved road*	-97.96	-1.18	0.238	-86.00	-1.02	0.307
Dummy fok. with no road - far distance to paved road	-241.93	-2.76	0.006	-213.24	-2.34	0.020
Dummy fok. with all-season road - close distance to paved road	-26.58	-0.44	0.662	-15.04	-0.24	0.808
Dummy fok. with all-season road - medium distance to paved road	-168.96	-2.44	0.016	-170.96	-2.41	0.017
Dummy fok. with all-season road - far distance to paved road	-161.13	-2.42	0.016	-146.11	-2.15	0.033
Dummy fok. with seasonal road - close distance to paved road	-112.84	-1.51	0.132	-84.26	-1.10	0.275
Dummy fok. with seasonal road - medium distance to paved road	-152.13	-2.24	0.027	-124.89	-1.73	0.085
Dummy fok. with seasonal road - far distance to paved road	-204.16	-2.71	0.007	-176.30	-2.23	0.027
Dummy possibility of choice traders (1=yes)				67.25	1.77	0.079
Index soft infrastructure				27.48	1.84	0.067
Dummy fivondronana Fianarantsoa II	-105.52	-1.62	0.108	-104.04	-1.61	0.109
Dummy fivondronana Ikongo	141.35	1.74	0.083	131.18	1.62	0.107
Dummy fivondronana Manakara	16.03	0.24	0.812	26.14	0.38	0.701
Dummy fivondronana Marovoay	24.91	0.28	0.780	-13.14	-0.15	0.883
Dummy fivondronana Bealanana	-341.51	-4.25	0.000	-281.17	-3.36	0.001
Dummy fivondronana Mampikony	-43.18	-0.57	0.570	-65.47	-0.87	0.387
Dummy fivondronana Antsirabe	52.19	0.65	0.516	44.06	0.56	0.580
Total number of observations	188			188		
Adjusted R2	0.309			0.324		
F-value	6.556			6.27		

Source: Own calculations based on IFPRI/FOFIFA - community survey, 1997 (n=188 communities)

*close to paved road: less than two hours walking; medium distance: between two and eight hours; far: more than eight hours

** independent variables include only hard infrastructure

The average time required to get to the main road is calculated for each of these categories (Table 7). Coefficients are aggregated using the relative weights of the different villages to estimate the overall effect of road quality and distance. A calculation of the average price decline per km or per hour of traveling time shows that it amounts overall, weighted by the importance of each category, to 24 Fmg/kg/hour or 8 Fmg/kg/km[15]. There seems to be some leveling off in the effect of distance on prices the further one has to go. The price declines are relatively larger the closer one is to the main road
and amount to 13 Fmg/kg/km for the closest category, and 10 Fmg/kg/km for the medium category[16]. For the far away category, price declines are only 2 Fmg/kg/km. This might partly be due to the fact that the further one is from the main road, the more economic it becomes to use other and cheaper means of transport than transport by foot. However, even if one uses the same means of transportation, there are natural economies of scale over longer distances which reduce per unit transportation costs.

Mendoza and Randrianarisoa (1998) estimate the transportation costs based on an output trader survey in the same period and in the same regions as about 2 Fmg/kg/km for trucks and lorries, 5 Fmg/kg/km for ox-carts, and 14 Fmg/kg/km for the pousse-pousse or calèche. Hence, these figures are of the same order of magnitude, since the former are used for long distances and

[15] The exchange rate at the time of the survey was around 4500 Fmg/US$.

[16] These estimates are consistent with the salary levels. An average salary in the region amounts to 6 kapoaka of rice a day, which is equivalent to 2100 Fmg in the harvest season. Assuming that one person can transport one bag of rice (50 kg), this would amount to a daily salary of 2200 Fmg.

Table 7-Calculation of decline of producer prices in function of transport infrastructure and distance to paved road

	Percentage of villages	Coefficient regression	Time to paved road (hours)	Fmg/kg/hour	Fmg/kg/km
Fokontany with paved road	7.6				
Fokontany with no road - medium distance to paved road*	5.1	-97.96	3.33	-29.44	-9.81
Fokontany with no road - far distance to paved road	5.2	-241.93	33.54	-7.21	-2.40
Fokontany with all-season road - close distance to paved road	24.3	-26.58	0.93	-28.43	-9.48
Fokontany with all-season road - medium distance to paved road	14.0	-168.96	5.60	-30.15	-10.05
Fokontany with all-season road - far distance to paved road	11.6	-161.13	26.60	-6.06	-2.02
Fokontany with seasonal road - close distance to paved road	7.6	-112.84	1.49	-75.88	-25.29
Fokontany with seasonal road - medium distance to paved road	13.3	-152.13	5.26	-28.94	-9.65
Fokontany with seasonal road - far distance to paved road	11.3	-204.16	35.73	-5.71	-1.90
TOTAL	100.0			-23.95	-7.98
Aggregated along distance					
Fokontany at a close distance to the paved road	31.9			-39.72	-13.24
Fokontany at a medium distance to a paved road	32.4			-29.54	-9.85
Fokontany at a far distance to a paved road	28.2			-6.13	-2.04
Aggregated along road quality					
Fokontany with no road	10.3			-18.18	-6.06
Fokontany with all-season road	49.9			-23.71	-7.90
Fokontany with seasonal road	32.2			-31.83	-10.61

Source: Own calculations based on IFPRI/FOFIFA - community survey, 1997 (n=188 communities)
*close to paved road: less than two hours walking; medium distance: between two and eight hours; far: more than eight hours

the latter for short ones. They also illustrate the close relationship between the decline in agricultural prices and the cost of transportation, and seem to indicate that most of the spatial differences in agricultural producer prices in the harvest period are explained by transportation costs[17].

The type of road does not seem to have a significant impact on the cost per hour traveled. The cost per hour to transport goods seems to not vary by type of road but influences the time required to get to the paved road. If an all-season road exists, one can get to the main road faster than if there is no easy road at all. The quantitative implications of upgrading (or worsening) road infrastructure on rice prices are clear. Communities that are far away from the main paved road receive, on average and using
the regression results, a rice price that is 13 percent to 18 percent lower, depending on the type of infrastructure, than the price on a paved road.

Not only is hard infrastructure a determinant of price levels, but soft infrastructure and the possibility of choice between traders are as well. Access to credit, banks, telephones, radio-contact (BLU), extension, etc. might cause increased production levels, better access to output markets, better information flows, and might therefore increase producer prices. As can be expected, distance to the paved road is correlated to soft infrastructure and to the choice among traders. An alternative model was run in which these variables were added to the regression (Table 6 - Model 2). While the inclusion of these variables reduces the significance of some coefficients on hard infrastructure, the explanatory power of the regression increases, indicating that these

[17] Results in the former Zaire also show that transportation costs explain most of those spatial differences, i.e. around three quarters of the producer - wholesale margin (Minten and Kyle 1995).

variables affect price levels, in addition to hard infrastructure. Both coefficients turn out to be significant. If farmers in a fokontany can choose between traders to sell their products, price levels are 67 Fmg/kg or 6 percent of the average rice price higher, ceteris paribus. Soft infrastructure also increases price levels and shows an elasticity of 3.3 percent. In short, these results seem to imply that creating hard infrastructure is a necessary, and quantitatively the most important determinant, of increased producer prices. Soft infrastructure has a beneficial influence, over and above the effect of hard infrastructure, but its effect on the price is small during the harvest period when most households sell.

MARKET ACCESS

Determinants of market access are looked at in this section. To this end, models are estimated that evaluate the impact of the determinants on choice between traders for the main agricultural products and the number of traders that buy at the community level. The choice between traders and the number of traders that buy is assumed to be related to infrastructure as well as the size of the village and population density in the region. Correspondingly, lack of choice might be linked to low market volumes that inhibit traders to come and buy products. The results of these regressions are shown in Table 8.

The regression results suggest that choice between traders is negatively related to the distance to market sites (the variable is significant at 15 percent). As shown in the household level analysis (Minten et al. 1998), a great deal of the trade in agricultural products happens in regular market sites

Table 8-Determinants of choice between traders and number of traders over the last year

Variable	Choice between traders (logit)		Number of big traders (tobit)		Number of small collectors (tobit)	
	Coefficient	z-value	Coefficient	z-value	Coefficient	z-value
Intercept	0.232	0.205	-1.617	-0.039	82.808	1.001
Fokontany with no road - medium distance to paved road*	1.529	1.207	-47.303	-1.297	12.473	0.170
Fokontany with no road - far distance to paved road	2.412	1.502	-248.730	-0.066	5.518	0.068
Fokontany with all-season road - close distance to paved road	0.834	1.067	-57.832	-2.104	15.185	0.256
Fokontany with all-season road - medium distance to paved road	1.770	2.032	-22.095	-0.770	40.360	0.661
Fokontany with all-season road - far distance to paved road	1.086	1.153	-20.989	-0.658	94.841	1.447
Fokontany with seasonal road - close distance to paved road	0.841	0.873	-112.500	-2.663	73.463	1.032
Fokontany with seasonal road - medium distance to paved road	1.598	1.481	-18.982	-0.553	-10.646	-0.159
Fokontany with seasonal road - far distance to paved road	1.786	1.388	-11.184	-0.282	75.115	1.031
Distance to market	-0.176	-1.478	0.956	0.251	-2.954	-0.447
Soft infrastructure index	-0.306	-1.467	14.673	1.994	8.213	0.639
Population fokontany	0.000	0.406	0.002	0.705	-0.004	-0.611
Population density	0.004	1.493	0.009	0.130	-0.045	-0.412
Dummy fivondronana Fianarantsoa II	-0.281	-0.353	29.376	0.994	14.891	0.257
Dummy fivondronana Ikongo	12.116	0.057	-47.506	-1.254	41.899	0.617
Dummy fivondronana Manakara	0.539	0.560	-33.024	-1.062	-83.490	-1.401
Dummy fivondronana Marovoay	2.131	1.472	12.088	0.324	-197.750	-2.360
Dummy fivondronana Bealanana	-3.073	-2.645	-275.850	-0.082	31.316	0.431
Dummy fivondronana Mampikony	1.598	1.377	-76.772	-1.855	-93.044	-1.359
Dummy fivondronana Antsirabe	-0.798	-0.785	-53.176	-1.318	-56.932	-0.785
Number of observations	188		145		145	
Log likelihood function	-76.75		-294.19		-758.79	

Source: Own calculations based on IFPRI/FOFIFA - community survey, 1997

*close to paved road: less than two hours walking; medium distance: between two and eight hours; far: more than eight hours.

while a minority happens in the village itself. Hence, the closer the village is to a market site, the higher the probability that the village reports the possibility of choice between traders. However, the influence of market sites on choices might be limited in some cases because the number of wholesalers per market site is low[18]. The population density and size of the village show the expected positive, but statistically insignificant, effect on choice between traders. Traders might find it profitable to go to those villages and areas as they are more likely to ensure a load and experience less search costs because the total commercial surplus is higher.

The possibility of choice between traders is not directly positively related to hard and soft infrastructure. Various reasons may explain this. First, regions that are better endowed with infrastructure seem to rely more on contract agriculture than regions with less infrastructure[19]. Second, there is evidence that in some regions farmers lock themselves into credit relations with traders (Zeller 1994; Barrett 1997). These traders provide those farmers with cash, food, or access to agricultural inputs during the lean period in exchange for part of their products during the harvest period. Because of these kinds of relationships, farmers might feel that they have no choice with respect to output channels. This practice might exist more in fokontany that are endowed with better infrastructure since they may be better able to establish those longer-term relationships while the fokontany further away have to rely more on itinerant

[18] For example, Barrett (1997) reports an average of only 1.5 pure wholesale collector per periodic market area in the Vakinankaratra region.

[19] For example, wheat, barley and seed multiplication in the Vakinankatra region and cotton, beans, and tobacco in the Mahajanga area.

traders or sub-collectors who go to villages to fill bags and oxcarts[20]. Moreover, Fafchamps and Minten (1998) show that bigger traders tend to rely more on regular suppliers and longer-term relationships than smaller ones do. The tobit models presented in Table 8 show that bigger traders tend to have more activities in fokontany with better hard and soft infrastructure while the regression on small collectors shows that their number is not related to infrastructure and distance, i.e. they have activities in all the fokontany irrespective of infrastructure.

Moreover, there might also be methodological problems with infrastructure variables as separate determinants of market access[21]. Disentangling the effect of the different types of infrastructure is difficult as distance to markets and soft infrastructure are related to hard infrastructure. While invoking causality would be inappropriate, Table 9 illustrates the close relationship very well. Communities that are located on a paved road show an average soft infrastructure index that is four times as high as for villages located far from a main road. In general, the further villages are located from the main road and the lower the quality of infrastructure, the lower the index of soft infrastructure.

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[20] Fraslin (1997) mentions for example that in well-endowed irrigation areas (the "Petit Perimètres Irrigués") in the Highlands, one third of the harvest is already sold before the actual harvest ("vente sur pied") during certain seasons.

[21] As well as with market access variables. While one big collector or miller has several sub-collectors that operate for him, they might give the impression of choice in villages or markets where the collector is not located. However, this is not the case in the better endowed places where the big collector is located. Given the often pyramid trading structure in the rice market for example - from many sub-collectors to one or only a few big collectors/millers - this might give a distorted image of the possibility of choice.

Distances to regular markets show the same trends. Villages that are located on the main paved road are less than one hour away from a market site, while the villages that are located far from the paved road and that have no road or only a seasonal road are, on average, more than 4 and 5 hours away from a market site. These averages illustrate that soft, market, and hard infrastructure tend to be located in the same places. Hence, it should be kept in mind that there is collinearity with the variables in the regressions and that this might influence interpretation. On the other hand, they are not perfectly correlated as the inclusion of extra infrastructure variables increases the explanatory power in the different models that are presented.

Table 9-Relation between soft, market, and hard infrastructure

Road category	Mean Soft index	Time (hours) required to get to market site
Fokontany with paved road	2.41	0.89
Fokontany with no road - medium distance to paved road*	1.19	1.14
Fokontany with no road - far distance to paved road	0.73	4.31
Fokontany with all-season road - close distance to paved road	1.67	1.35
Fokontany with all-season road - medium distance to paved road	1.57	0.61
Fokontany with all-season road - far distance to paved road	1.36	1.07
Fokontany with seasonal road - close distance to paved road	1.20	1.84
Fokontany with seasonal road - medium distance to paved road	0.77	2.52
Fokontany with seasonal road - far distance to paved road	0.92	5.56
Total	1.36	2.00

Source: IFPRI/FOFIFA - community survey, 1997 (n=188 communities)
*close to paved road: less than two hours walking; medium distance: between two and eight hours; far: more than eight hours

PRICE VARIABILITY

While high price levels during the harvest period are clearly very important for income generation of the selling households (60 percent of the rural households in the case of rice), so are low price levels during the lean season as a

significant proportion of rural households become buyers during that period (80 percent of the rural households). The results of the regression on the determinants of the seasonal spread are presented in Table 10. As the focus is on rice price variability, alternative regressions were run for those villages where rice presents more than 50 percent (the "rice villages") and less than 50 percent (the "non-rice" villages) of total income in the village.
This distinction might reflect villages that are relatively more self-sufficient in rice compared to villages that are relative net importers of rice.

Different reasons can be invoked for seasonal price movements in Madagascar. The first is the cost of capital. Previous studies in Madagascar seem indeed to indicate that access to credit and a well-functioning rural financial system are critical for traders and rural households alike to ensure an efficient functioning of markets (Badiane et al. 1997; Zeller 1993). If the costs of borrowing are higher due to credit shortages, the costs of working capital will be high and the incentives for quick turnover by traders or storage agents will be great. This might reduce the size of the working stock and diminish buffers against transitory food shortages. One might therefore expect that to the extent that the economic reforms have constricted credit to traders, there might be a higher variability (Alderman and Shively 1996). On the other hand, opportunity costs for rural households are also high as they often need to sell products to pay back loans. Informal lenders in rural areas charge about 60 percent annual interest rate on loans (Zeller 1993).

Table 10-Determinants of seasonal spread in rice prices (Oct. 95 - Sept. 96)

Independent variables	Overall		Non-rice villages**		Rice villages	
	Coefficient	t-value	Coefficient	t-value	Coefficient	t-value
Intercept	1141.3	3.194	1721.1	3.017	1832.4	3.976
Dummy fok. with no road - medium distance to paved road*	200.1	0.953	450.1	1.742	-356.5	-1.169
Dummy fok. with no road - far distance to paved road	-72.8	-0.318	307.0	1.054	-208.0	-0.621
Dummy fok. with all-season road - close distance to paved road	101.6	0.663	-2.2	-0.012	172.1	0.758
Dummy fok. with all-season road - medium distance to paved road	225.6	1.328	378.5	1.721	-108.2	-0.439
Dummy fok. with all-season road - far distance to paved road	121.5	0.702	266.3	1.198	-120.2	-0.530
Dummy fok. with seasonal road - close distance to paved road	63.7	0.349	89.5	0.366	-0.5	-0.002
Dummy fok. with seasonal road - medium distance to paved road	168.6	0.965	339.8	1.550	-37.9	-0.153
Dummy fok. with seasonal road - far distance to paved road	242.2	1.193	656.2	2.670	-255.9	-0.840
Dummy possibility of choice output traders (1=yes)	-177.2	-1.954	-86.0	-0.542	-2.4	-0.021
Index soft infrastructure	-74.4	-1.935	9.1	0.156	-68.9	-1.286
Percentage of households without land	4.2	2.487	3.2	1.458	2.4	0.635
Climatic and disease risk index	8.9	1.831	3.5	0.560	3.1	0.426
Time to get to market site (hours)	-31.7	-2.131	54.9	1.912	-37.4	-2.196
Dummy savings group (1=yes)	40.2	0.362	-481.3	-2.531	55.6	0.424
Dummy mutual help group (1=yes)	-115.8	-1.407	-85.0	-0.705	-188.6	-1.738
Dummy Communal Storage Scheme (1=yes)	35.6	0.274	-89.5	-0.348	-102.6	-0.737
Dummy formal credit (1=yes)	-30.0	-0.297	5.1	0.036	-229.3	-1.776
Dummy informal credit (1=yes)	-48.9	-0.602	-57.9	-0.540	-228.0	-1.893
Real wage level (in number of kapoaka of rice per day)	0.1	1.152	0.0	0.236	0.2	1.675
Dummy fivondronana Fianarantsoa II	-32.3	-0.201	105.4	0.354	-385.2	-1.388
Dummy fivondronana Ikongo	121.3	0.537	106.9	0.375		
Dummy fivondronana Manakara	13.0	0.074	175.5	0.827	74.2	0.233
Dummy fivondronana Marovoay	362.1	1.700	-60.2	-0.192	217.8	0.651
Dummy fivondronana Bealanana	1269.9	5.835	1812.3	5.897	954.6	3.042
Dummy fivondronana Mampikony	786.3	4.025	876.8	3.887	204.4	0.616
Dummy fivondronana Antsirabe	71.9	0.380	144.9	0.744	-463.1	-1.180
Total number of observations	188		188.0		188	
Adjusted R2	0.468		0.633		0.575	
F-value	7.234		6.904		6.089	

Source: Own calculations based on IFPRI/FOFIFA - community survey, 1997 (n=188 communities)

*close to paved road: less than two hours walking; medium distance: between two and eight hours; far: more than eight hours

** non-rice villages: villages where rice represents less than 50% of income; rice villages: rice represents more than 50% of village income

However, there is also severe credit rationing so shadow costs for credit-constrained households are even higher (Zeller 1994). These high opportunity costs induce the rural households to sell immediately after harvest, flood the market with produce, and therefore increase the seasonal spread.

Most of the variables that measure capital costs and that were included in the regression - presence of formal credit, informal credit, a communal storage scheme, savings groups, mutual help groups in the village - show the expected negative sign but none of them are significant at the overall level. However, the magnitude of the coefficients of these variables increases and the coefficients become highly significant in the regression for the rice villages alone. In this case, the presence of formal and informal credit together reduce the seasonal spread by 18 percent. It seems that access to credit effectively reduces the cost of storage through a reduction of the cost of capital in the rice villages. The seasonal spread on rice prices in non-rice villages might be less affected by access to credit as these villages do not have enough rice to store in any event, even if the cost of capital is reduced. The coefficient on mutual aid groups turns out to be significant in the rice villages while savings groups are significant in the non-rice villages. Adding soft infrastructure to credit matters as it shows a negative and significant sign in the overall regression. Its elasticity is evaluated at 6 percent.

The significance of the coefficient on the percentage of households without land - presumably also net buyers of rice - as a measure for the level of poverty seem to indicate that the higher the level of poverty in the village, the higher the seasonal spread in the overall regression. The significance of this term seems mostly to be driven by the non-rice villages. Demand for rice in this case might be more likely to be met by imported rice in the village and hence transport costs from the city, where most of the storage seem to occur, to the village have to be

imputed and added to the seasonal spread. On-farm storage losses also contribute to seasonal price patterns. Previous research indicates that this does not seem to be the main reason for seasonal movement as few farmers report this as their main problem (Randrianarisoa 1997). However, physical quantity losses seem to be real due to humidity losses. It would have been expected that the higher the co-variant risk in the village, measured by the number of climatic and plant disease calamities over the last ten years, the less overall production, the more storage losses, and/or the faster the village wants to sell its harvest, and hence, the higher the seasonal spread. However, while the coefficients on risk show the expected sign, they are not significant.

Hard infrastructure shows little direct effect on the seasonal spread in the overall regression. However, hard infrastructure becomes highly significant for the non-rice villages. In this case, rice is imported to the village in the lean season and the positive sign on distances to the main road and on quality of infrastructure reflects transportation costs from the paved road to the village. The distance to the market shows a significant negative sign for the overall regression. It is interesting to note that the distance to the market has different effects on the rice villages compared to the non-rice villages. The distance to the market site shows a significant negative effect on the seasonal spread for the rice villages. One extra hour away from a market site would reduce the seasonal spread by 50 Fmg/kg (the elasticity is evaluated at 10.3 percent). It might be the case that rice villages with more difficult access to a market site store more themselves and reduce seasonality in that way. Rice villages with access to a market might participate relatively more in market transactions, and sell during harvest and buy during the lean period. For the non-rice villages, the seasonal spread increases significantly with the distance to the market site. This reflects transport costs imputed for the rice brought into the village during the lean season. The elasticity is evaluated at 5.5 percent.

One other potential explanation for seasonal price movements is that traders manipulate prices and increase profits by monopsony buying at harvest time or monopoly selling in the lean period or both. Traders could extract profits from farmers through creditor-debtor relationships or through tied transactions to keep farmers at a bargaining distance (Alderman and Shively 1996; Sahn and Delgado 1989). To a certain extent, this seems to be the case as the coefficient on the possibility of choice between traders variable turns out to be large and significant in the overall regression. Prices during the harvest season tend to be lower (as seen in the regression in the previous section), prices during the lean season higher, and seasonal gaps bigger in those communities where no choice between traders exists. Seasonal gaps are 12 percent higher for villages that have no choice between traders compared to villages that have the choice, ceteribus paribus. In the previous section the regressions show that prices during the harvest season are 67 Fmg/kg lower if communities had no choice. The combination of choice effects during harvest time and the lean period imply that seasonal gaps are 177 Fmg/kg bigger for communities with no choice. However, the results on the choice in traders are not robust as shown in the regressions that are split up for rice and non-rice villages.

4. CONCLUSIONS

This paper documents access to infrastructure, output markets and rural agricultural prices based on a recent community survey in Madagascar. Market infrastructure development is low as only 8 percent of the communities report having to access to a paved road and to a local market. It is shown that there are significant seasonal movements in food marketing as rice prices in rural areas are more than twice as high during the lean period than during the harvest period. There is significant spatial variation as well, as prices are 40 percent and 27 percent higher in the lean and harvest period respectively in the higher priced region compared to the lower priced region. This regional and temporal averages hide even more variability at the village level.

The analysis links the price variation to structural determinants. Hard infrastructure is an important determinant of producer price levels. Price levels decrease significantly as the distance to main roads increases and the quality of infrastructure decreases, and they decrease relatively faster over shorter distances than over longer distances. It is shown that distance matters more than road quality as there is no strong relationship between road quality and the decline of producer prices per unit of time, and as increased quality decreases time traveled only marginally. Moreover, road infrastructure does not automatically lead to more competition among traders as hard infrastructure by itself does not seem to increase the possibility of choice between traders.

Low seasonal price variation is important for rural communities as the majority of rural households are sellers after the harvest period and buyers in the lean period. It seems that rice price variability is related to distance to road and

quality of hard infrastructure. This seems to be the case especially for villages where rice is less important as a source of revenue. Villages far off the main road are extra vulnerable due to increased seasonal gaps and lower prices for their products during the harvest season. On the other hand, access to formal and informal credit reduces the seasonal spread significantly in those villages where rice is an important source of income.

Significant rural price variation in Madagascar reflects high transportation costs, due to deficient road infrastructure and reversal of flows from rural to urban areas, and high opportunity costs of capital. Adding investment in soft infrastructure to hard infrastructure seems to be beneficial to successfully increase producer prices, to reduce food price variability, and to improve market integration. The methodology used complements the results from most price integration studies as it highlights the importance of different causes for price variation and lack of co-variation between communities. In so doing, it should help lead to more relevant and appropriate policy answers.

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